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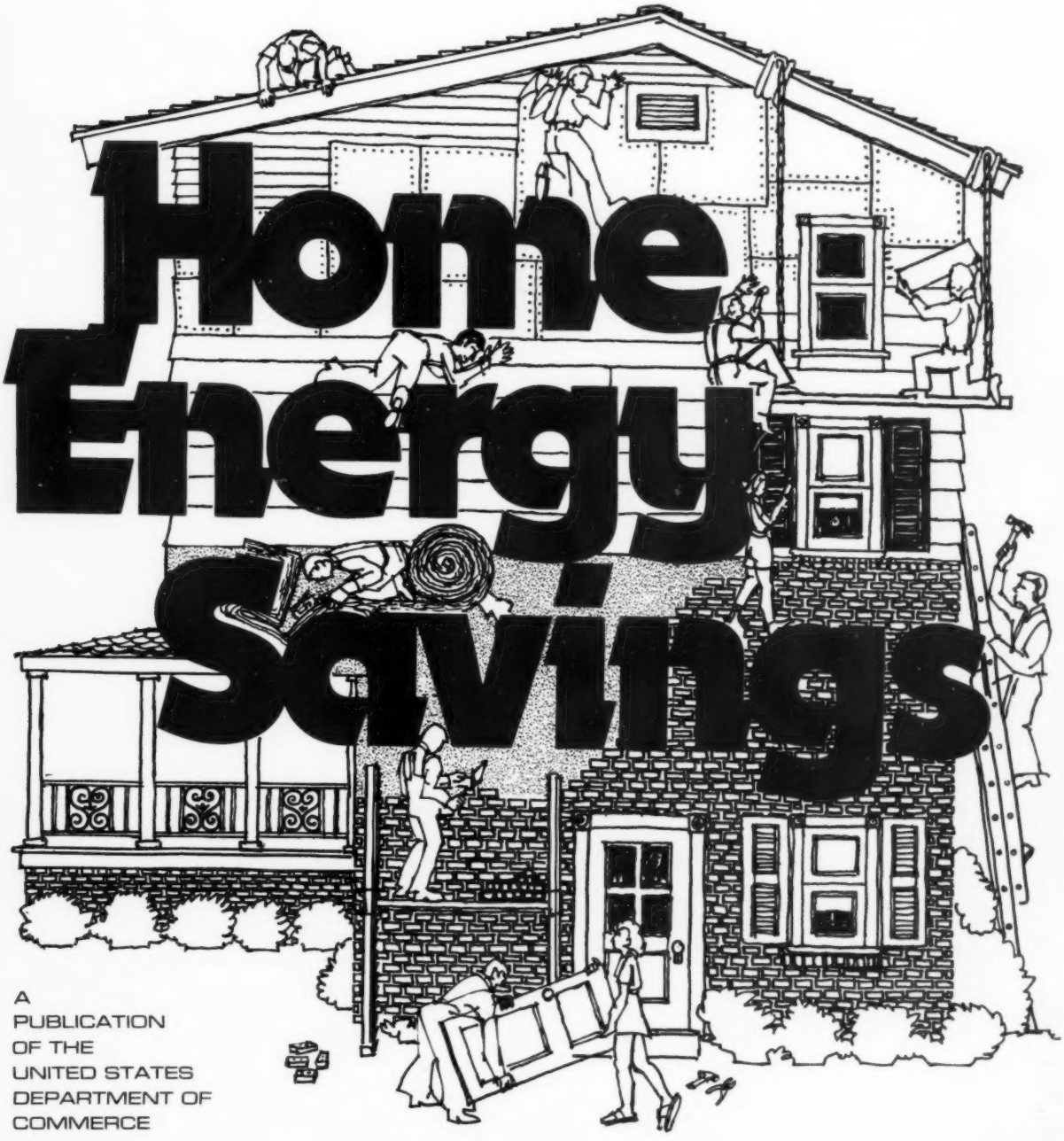

Home Energy Savings

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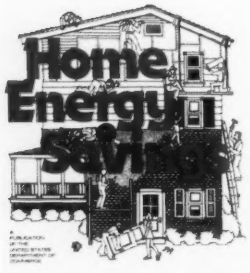

Cover: Due to higher energy costs and more limited energy supplies, many homeowners are attempting to cut their home energy consumption. A new set of guidelines developed by NBS and the Federal Energy Administration allows a homeowner to calculate the best combination of energy conservation improvements that will give him the largest, long-run savings on heating and cooling expenses. See article on page 27 for details.

The National Bureau of Standards serves as a focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. For this purpose, the Bureau is organized as follows:

The Institute for Basic Standards
The Institute for Materials Research
The Institute for Applied Technology
The Institute for Computer Sciences and Technology
Center for Radiation Research
Center for Building Technology
Center for Consumer Product Safety

Formerly the TECHNICAL NEWS BULLETIN of the National Bureau of Standards.
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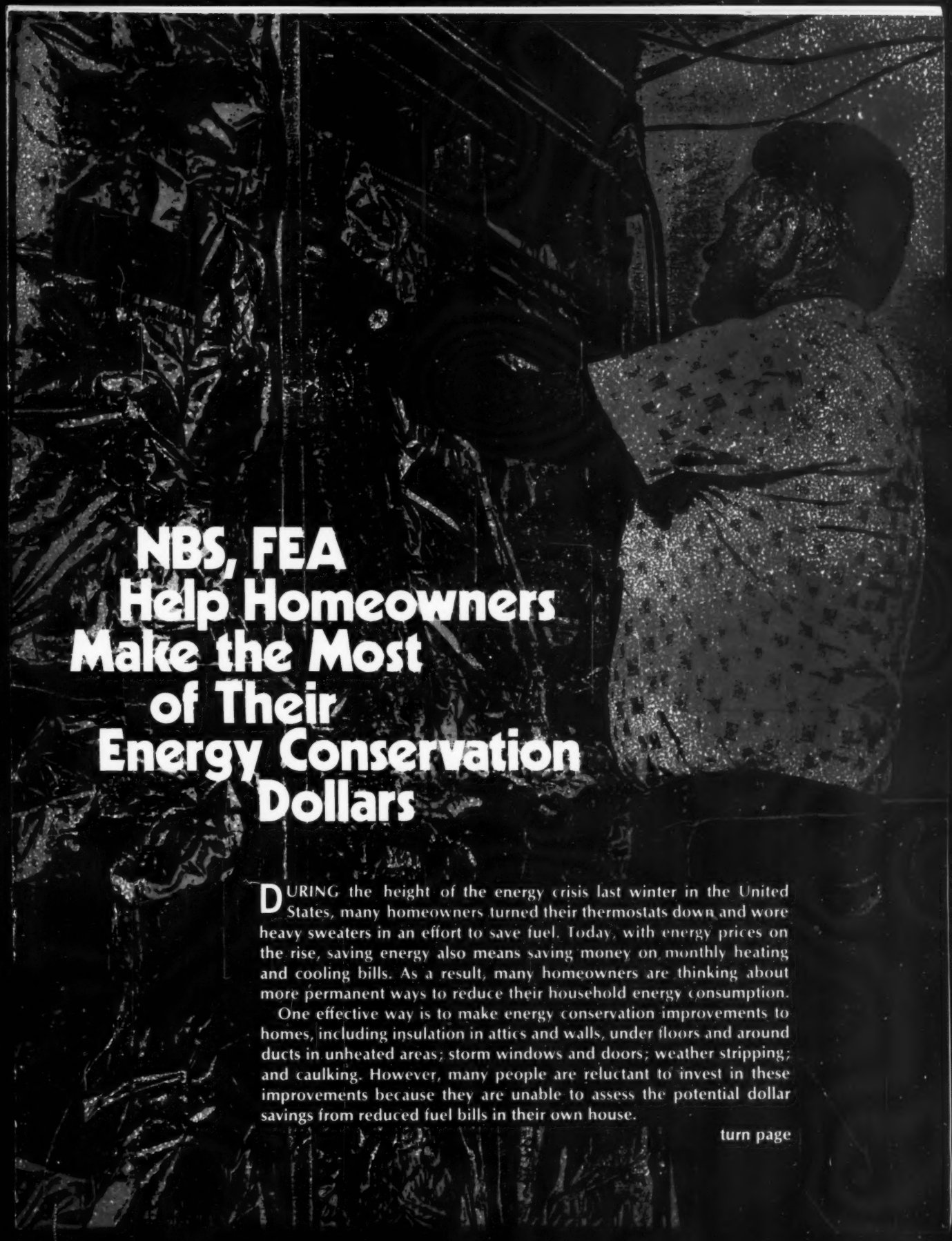

NBS, FEA Help Homeowners Make the Most of Their Energy Conservation Dollars

DURING the height of the energy crisis last winter in the United States, many homeowners turned their thermostats down and wore heavy sweaters in an effort to save fuel. Today, with energy prices on the rise, saving energy also means saving money on monthly heating and cooling bills. As a result, many homeowners are thinking about more permanent ways to reduce their household energy consumption.

One effective way is to make energy conservation improvements to homes, including insulation in attics and walls, under floors and around ducts in unheated areas; storm windows and doors; weather stripping; and caulking. However, many people are reluctant to invest in these improvements because they are unable to assess the potential dollar savings from reduced fuel bills in their own house.

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Now there is help from the National Bureau of Standards and the Federal Energy Administration for homeowners who want to get the most for their money when making energy conservation improvements to their houses. Economist Stephen R. Petersen in the Bureau's Center for Building Technology has developed a set of guidelines which were used to calculate the best combination of energy conservation improvements to give a homeowner the largest, long run net savings on heating and cooling expenses. A unique feature of the guidelines is that they reflect a wide range of energy prices and climate regions.

"These guidelines may hold a few surprises for homeowners who are used to thinking of 6 inches of insulation in their attics as being sufficient," Petersen says. The guidelines are based on his research which shows that, because of rising energy prices, 6 inches of insulation are economical for a homeowner in most climates only if he uses low priced natural gas for heating. Nine to 12 inches of insulation for attics in oil heated homes will generate the greatest long run return on initial investment, except in the milder climates. Twelve or more inches of insulation may be economically justified in many houses which are both electrically heated and cooled, according to Petersen's studies.

Typical House

As an example of these economic guidelines, Petersen calculated the best combination of energy conservation improvements for a house located in the Washington, D.C., area using fuel oil to heat and electricity to cool. This best combination includes 9 to 10 inches of insulation in the attic, 6 inches of insulation around ducts in the attic, 6 inches of insulation under floors over unheated areas, 3½ inches of wall insulation, and 4 inches around ducts in unheated areas other than attics. The house should also have storm windows over all primary windows larger than 9 square feet in size and all windows and doors should have weather stripping and caulking. However, a storm door may not be a good investment for this house unless the owner wants it not only to save energy but also for security and for use as a screen door in nonheating months.

Petersen emphasizes that the guidelines for homeowner energy conservation improvements are "balanced," and that the word has two meanings. First, a balanced combination means striking a happy medium between energy consumption and energy conservation. Just as a homeowner may be spending too much on fuel and not enough on insulation, he could conceivably spend more on insulating his house than the reduction in fuel bills would economically justify.

A balanced combination also means that one energy conservation technique should not be used to the neglect of others. For example, the homeowner in Washington, D.C., would not be getting the most return on his investment if he put 10 inches of insulation in the attic, but neglected the use of storm windows.

Climate and Fuel Prices

One of the major findings of Petersen's technical studies is that the amount of money a homeowner should invest in energy conservation improvements depends equally on climate and fuel prices.

"A doubling of fuel prices has the same effect on a homeowner's energy budget as a doubling of climate factors," Petersen says. "For example, when prices for home heating oil doubled in the winter of 1973-74, the effect on a homeowner's heating bill was the same as physically moving his house located in Washington, D.C., to Minnesota.

This is why the more a homeowner pays for fuel, the more he should invest in energy conservation improvements. Potential savings on monthly fuel bills are greater when a homeowner uses a higher priced fuel. As a rule of thumb, electricity is more costly than fuel oil and fuel oil is more costly than natural gas.

Petersen also points out that the amount of savings on a monthly heating or cooling bill after energy conservation improvements are made depends on the existing condition of the house. "If the house is poorly insulated to begin with, it will require a greater investment in energy conservation improvements than a well insulated, tightly sealed house," Petersen explains. "But the dividends to the homeowner, in terms of greatly lowered heating and cooling bills, will be considerably larger for the poorly insulated house after the improvements are made."

For this reason, Petersen believes it is often to a homeowner's advantage to borrow money to finance his best combination of energy conservation improvements if he lives in a poorly insulated house. The savings on monthly fuel bills after the improvements are made will easily cover the interest the homeowner pays for the loan and the savings will continue to be realized long after the loan is paid off.

Good Investment

"Most people haven't thought about energy conservation improvements in this way," Petersen says, "but investing in them now is better than most alternative low risk investments a homeowner can make—like putting money in the bank." When a homeowner invests in energy conservation improvements, he immediately begins to earn dividends in the form of reduced utility bills, Petersen explains. These dividends go toward paying off his investment. "If fuel prices increase as expected, a homeowner's dollar dividends will grow," he points out. "Although the amount of fuel he saves each year will be fairly constant, increasing fuel prices will make these savings worth more—yielding additional dividends similar to interest received on other investments. And these additional dividends, unlike dividends from the bank, are not subject to income taxes."

Marginal Analysis

The guidelines for homeowners and the major findings concerning energy conservation improvements resulted from research carried out by Petersen during the last year. The research is part of ongoing economic studies sponsored by the NBS Office of Energy Conservation in cooperation with the Federal Energy Administration.

In his study, Petersen applied a well-known economic technique called marginal analysis. Marginal analysis is especially useful in determining the efficient allocation of productive resources in order to maximize their output. Here, the energy conservation improvements are the productive resources, and the net dollar savings (savings on utility bills less the cost of the improvements) are the output to be maximized.

In marginal analysis, as long as additional increments of investment (say, in energy conservation improvements) pay for themselves, they should be added. If an increment of one technique pays larger dividends per dollar invested than an increment of an alternative technique, it has a higher economic priority. When the last increment of each technique just pays for itself, a homeowner has a balanced combination of techniques that will pay greater net dividends (savings less costs) than any other possible combination. This is termed the "optimal marginal condition."

Petersen made two basic applications of marginal analysis. One application allowed him to select the optimal combination of energy conservation improvements for a given set of climatic, architectural and economic variables. The second application was used to select economically balanced combinations of improvements for a given investment size. Computer programs were written and implemented to solve for the economically optimal levels of investment in each energy conservation improvement.

The technical study, which describes Petersen's methods and conclusions, was published last month as NBS Building Science Series 64. The study, "Retrofitting Existing Housing for Energy Conservation: An Economic Analysis," is available as SD Catalog No. C13.29:2/64 from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. The price is $1.35. □

Estimating Gas Consumption

AUTOMOBILE gasoline consumption is a drain on the Nation's energy resources and an inefficient use of the energy we must conserve. Limited and costly energy resources will lead to the decline of single-person auto commuting and increase the use of public transportation. New transportation alternatives must be evaluated and transportation planners need to estimate the savings in automobile gasoline each alternative will provide.

Automobile gas consumption data will become even more important if Congress legislates minimum gas consumption rates for all new cars. Although some car manufacturers and government agencies test an individual automobile's gasoline consumption on the open road or under laboratory conditions, not enough is known about the effects on aggregate auto gas consumption of bumper-to-bumper rush hour traffic. To aid future transportation planning, the National Bureau of Standards is investigating techniques for estimating aggregate automobile fuel consumption in congested, peak hour traffic.

The study, by NBS researchers David Levinsohn and James McQueen, discusses existing procedures for estimating gasoline consumption in today's urban commuter driving conditions and suggests an estimation procedure which takes into account vehicle attributes and roadway operating conditions. Their study describes how factors such as vehicle weight and the number of stop lights per mile affect aggregate gas consumption on that street during a given time period.

In their study, Levinsohn and McQueen concluded that "present techniques for estimating auto gasoline consumption do not adequately account for the rush hour operating environment of the vehicle, or for the characteristics of vehicles which make up today's traffic volume flows."

The study began on Shirley Highway (Interstate 95), a congested commuter route between suburban northern Virginia and Washington, D.C. As a demonstration project, the Federal Highway Administration, the Urban Mass Transportation Administration and the Virginia Department of Highways decided to incorporate two bus priority lanes in a widened Shirley Highway. Federal funds helped construct the priority lanes, now also used by four-member carpools, and buy buses for expanded service. Since 1970, NBS has been evaluating the project and its implications for transportation planning.

"We want to determine the impact of bus lanes on travel patterns in northern Virginia," said Levinsohn. "One potential impact is that if we divert people from driving, we cut down on air pollution and save gas."

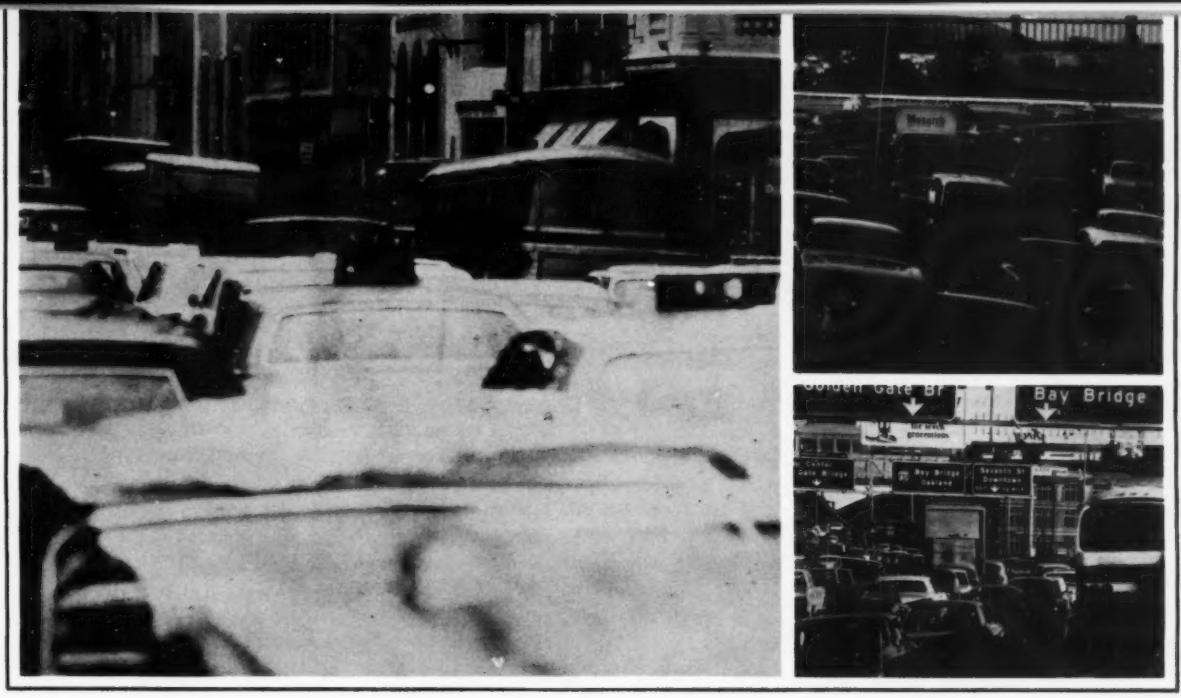
"The problem is how to compute the amount of gas being saved," Levinsohn noted. Knowing the aggregate gasoline savings will help determine the bus lanes' effectiveness.

The NBS researchers received funds from the Urban Mass Transportation Administration to estimate aggregate gas consumption on Shirley Highway. "When we found existing techniques for measuring gas consumption inadequate, we developed a new approach," said Levinsohn.

Factors Affecting Gasoline Consumption

Technically, every car consumes gasoline at a different rate, and different roadway conditions affect performance. However, aggregate gas consumption can be accurately estimated, according to Levinsohn, by grouping similar types of cars and similar driving conditions and then calculating consumption by group.

The NBS study groups cars by weight, age and accessory usage. Roads are divided into three main classifications: freeways, arterials and local streets. Operating factors affect-



Photos courtesy Department of Transportation

ing fuel consumption include attempted speed, stops per mile and roadway traffic volume.

According to previous studies, the most important vehicle characteristic affecting mileage is the car's weight. "A car that weighs 1125 kilograms (2500 pounds) gets about twice the mileage of one that weighs 2250 kg (5000 lbs) under the same driving conditions," Levinsohn noted.

Extra accessories also reduce car mileage. Air conditioning, when it's on, increases gasoline consumption by 6 to 20 percent, while automatic transmission increases gas consumption by 2 to 10 percent.

The car's age as it involves design factors is also important. Levinsohn noted, but it's not as simple as it looks. "In general," Levinsohn said, "new car mileage had decreased with each year's model up until the 1975 model year."

Primary changes which affect mileage include air pollution control devices and increased power. "Smaller cars suffer less from these changes in terms of lost mileage," Levinsohn added.

Roadway operating conditions also affect the performance of each type of vehicle. For instance, when cars on a somewhat congested expressway attempt to travel at 96 kilometers per hour (60 miles per hour) instead of 72 km/hr (45 mph), they use 9 percent more fuel. On a similarly congested urban artery, an increase in attempted speed from 48 km/hr (30 mph) to 64 km/hr (40 mph) results in a 39 percent increase in fuel consumption.

Increasing the number of traffic control signals per mile from zero to two produces a 58 percent increase in fuel consumption on an urban arterial highway. When the number of signals on a central business district street increases from zero to ten, fuel consumption goes up by 180 percent. Using these and similar reports as background information, the researchers were able to synthesize an effective estimation procedure.

Estimating Fuel Consumption

In the estimation procedure Levinsohn and McQueen devised, most factors affecting fuel consumption are taken into account. First they determine vehicle miles traveled for each vehicle type. This involves knowledge of the total number of vehicles, the percentage in each weight and age class and the road length under study.

Second, they compute base fuel consumption for each class of automobile and multiply it by the vehicle-miles computed in step one. Finally, they compute the adjusted fuel consumption figure, taking into account the different mileage each class of automobile attains. Completing the calculation, they arrive at the total fuel consumption for automobiles traveling a certain route during the rush hour.

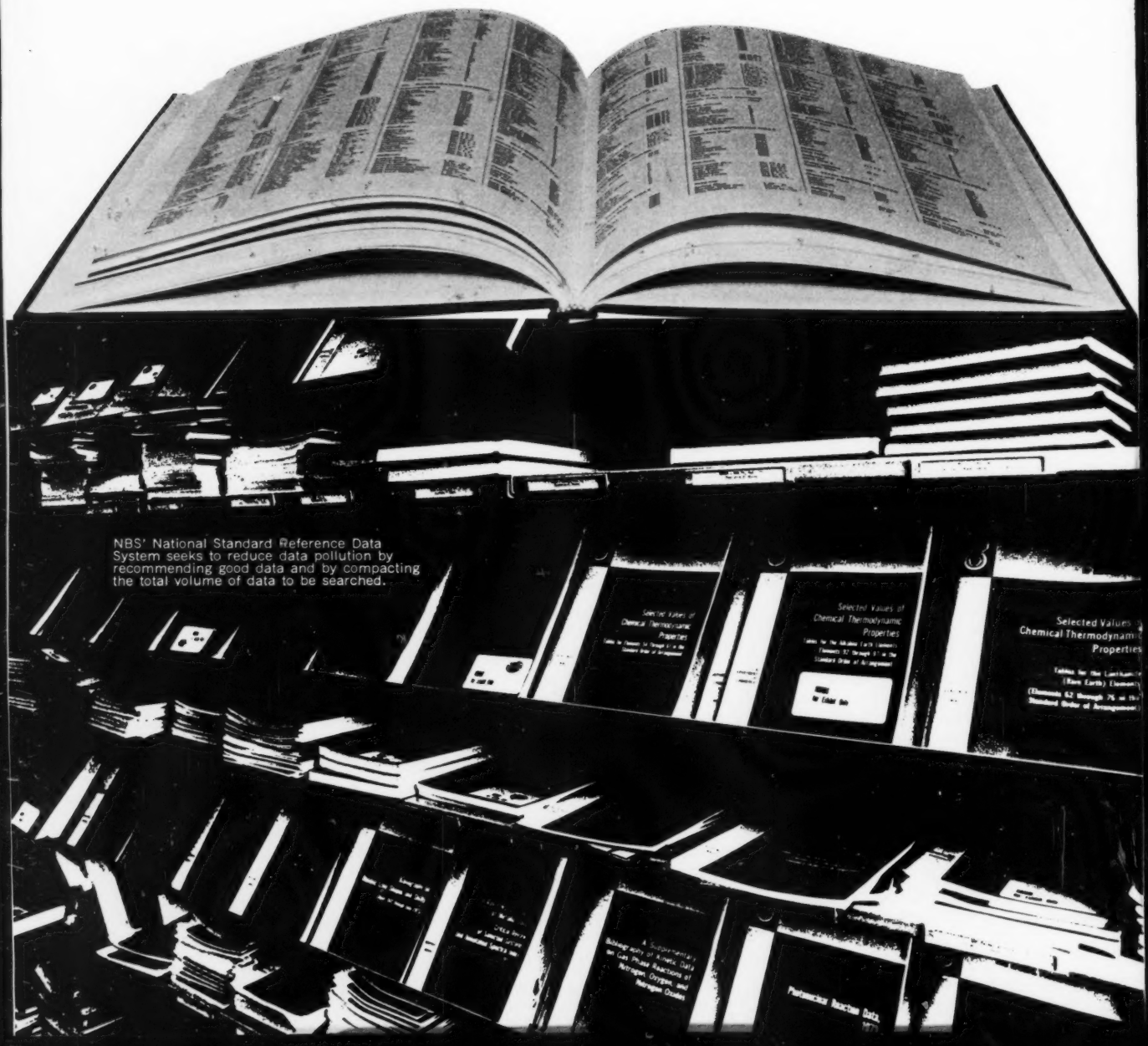
Further Research Needed

The NBS estimation procedure will be operable when all the variables involved—such as each car type's fuel consumption under each different road condition—have actually been measured. "The data do not exist yet," said Levinsohn. "What we need is someone to go out with each car group, in each condition, and measure fuel consumption."

The NBS researchers concluded that "if implemented, this approach to estimating gasoline consumption will allow planners to more accurately predict the energy impacts of transportation alternatives." New knowledge produced by this estimation procedure, Levinsohn said, could help evaluate alternative traffic control policies, policies aimed towards increased public transportation usage and policies encouraging manufacture and purchase of more energy-efficient automobiles. □

Good Science, Bad Data

Excerpted from a speech given by Dr. Richard W. Roberts, NBS Director, at the American Association for the Advancement of Science Symposium held January 27, 1975.



NBS' National Standard Reference Data System seeks to reduce data pollution by recommending good data and by compacting the total volume of data to be searched.

AS President Ford said on January 15, the State of the Union is not too good. The economy is slow, prices are high and our dependence on foreign oil is making a bad situation even worse. A major thrust of his message to the Nation was the imperative need to conserve energy.

You may legitimately ask what energy conservation has to do with good scientific data. My answer is— plenty. Mr. Ford is proposing tax credits for expenses incurred by homeowners in improving the thermal efficiency of their homes. But the homeowner needs valid, quantitative guidelines as to what steps to take. For example, is 15 centimeters (6 inches) of insulation in the attic enough? Is it more important to add storm windows than to weatherstrip? How cost effective is turning back the thermostat? Each of these questions requires reliable measurement data.

Good data are also needed on the efficiency of appliances and autos, on the performance of solar systems and on materials that will be used in reactors and MHD generators. Therefore, I see a direct and urgent link between the generation of valid quantitative information and the solution of one of this Nation's most pressing problems.

Many case studies—or horror stories—exist on the misuse of scientific data where the data involved were incomplete, inaccurate, or accidently or deliberately misused in an attempt to gain some particular goal. This is nothing new in the world of science, and the consequences today can be far reaching or even catastrophic. But let me go back in history to show that data have always presented a problem.

Consider the phlogiston theory popular in the 1700's. Phlogiston was widely believed to be a part of all substances, especially those elements that burned. The theory was that when sulfur, for example, was burned, it released its phlogiston during the combustion. When quantitative experiments proved conclusively that metals gained weight upon oxidation, the chemists came up with a very neat solution. What they did was assign phlogiston "negative weight." Thus, they said, when a metal lost its phlogiston during burning it very "reasonably" gained weight. Here was an early case of twisting facts to fit a prevailing theory. They were using good data, turning it into bad science.

The Problem Today

Science has come a long way from the days of the phlogiston theory. At that time its practitioners were few, their work was often unknown or unappreciated by the general population, and their triumphs had little immediate impact on the world at large. Today, of course, all that has changed. Science and technology have reshaped our way of life, scientists and their work are often highly visible to the general public, and the impact of decisions regarding the use of science are often widespread and fairly immediate. Therefore, the burden on science today is to operate from as factual a base as possible, by which I mean accurate data properly interpreted.

Unfortunately, finding accurate data is one of the major problems facing the scientific community. First, there is the sheer magnitude of the problem. Over a million scientific papers are published each year, and the publication rate is growing. These papers appear in approximately 35,000 journals, in dozens of languages. A large fraction of these papers report the results of some type of measurement. Thus, the mere task of keeping up with the new literature is almost beyond individual researchers in every field. Add these numerical results to the millions reported in past years, and the problem becomes even more immense.

Finding Valid Data

This problem of accurate data is not trivial. In most areas a researcher can, with diligent searching, find several reported values for the measurement of interest. Often, these values will disagree by a substantial amount.

Too often the paper contains insufficient information upon which to make judgments, and too often the reader is not expert enough in the specific field involved to make the required judgment.

What may result from pure frustration is the generation by the researcher of yet another value for the measurement in question, a number that may or may not be better than those already reported. Such a course is costly in time, money and wasted effort. Is there an answer to this problem of data pollution? The answer is yes, at a number of levels, and with a number of qualifying "ifs" tagged on.

Responsibilities

Let's start with the individual generator of data. He should have a legitimate reason for reporting his work. True, in some cases a paper is largely the result of the pressure to publish, an indication that we in

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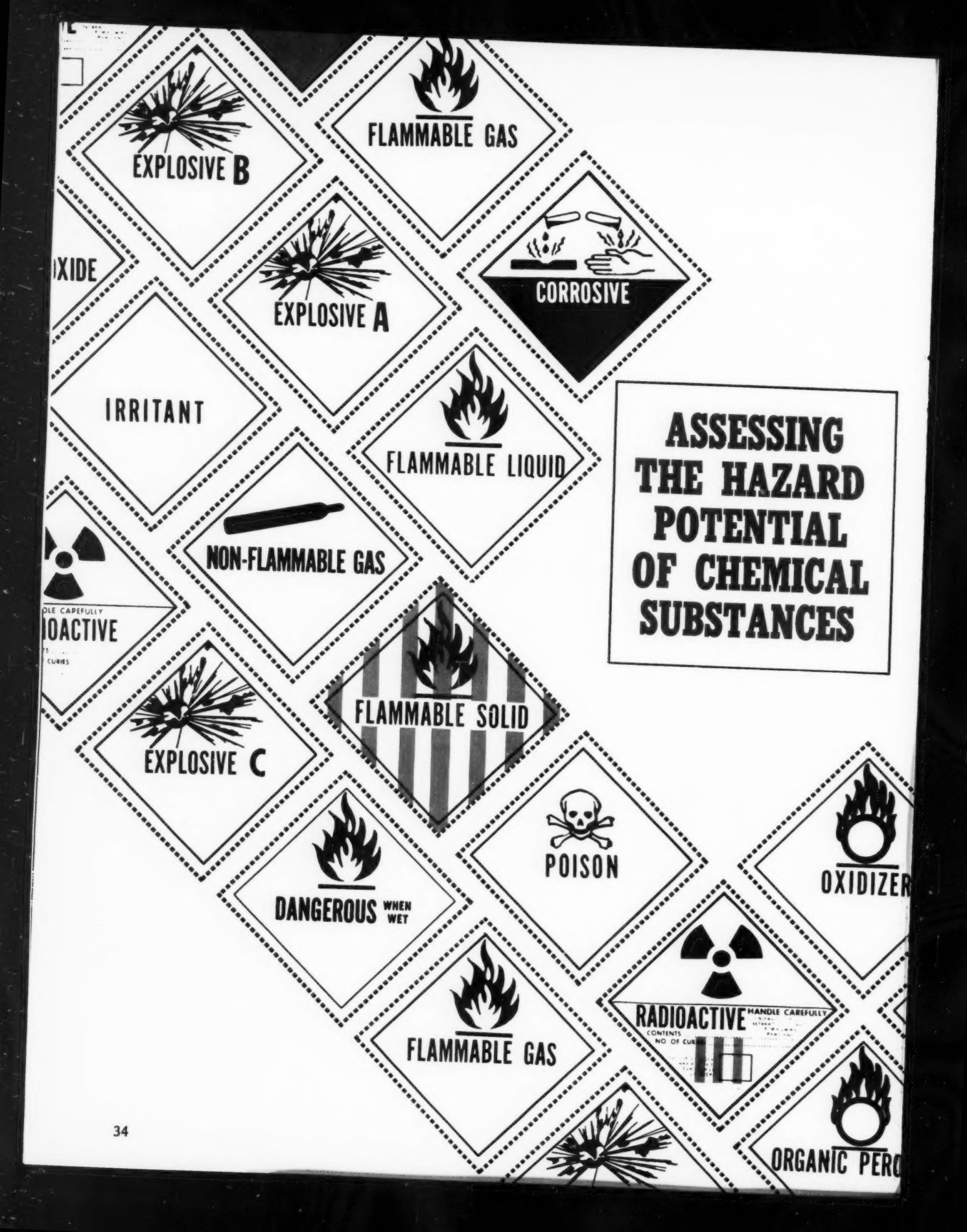


ASSESSING THE HAZARD POTENTIAL OF CHEMICAL SUBSTANCES

OVER the past two decades, the chemical industry has produced large quantities of certain well-established chemicals and has developed many new ones. Some from both of these two classes are potentially hazardous, and care must be taken in handling and shipping them from one location to another.

Of special concern are "self-reactive" or "thermally unstable" materials, which can decompose by themselves, even when packed carefully, if they encounter impact, friction or rapid and excessive heating.

Because of the large number of these thermally unstable chemicals on the market, the Hazardous Materials Regulation Board of the Department of Transportation (DOT) has asked the National Bureau of Standards' help in defining and identifying such hazardous materials. At NBS, chemists Eugene Domalski and Wing Tsang are evaluating procedures for identifying and ranking thermally unstable materials.

What Are Hazardous Materials?

Hazardous materials include those that are radioactive, explosive, toxic, corrosive or flammable, as well as those that are self reactive. The present work at NBS deals only with self-reactive materials.

Until recently, interest in identifying self-reactive materials has been limited to those concerned with explosives. While many self-reactive materials are unsuitable for use as explosives, they may behave just like explosives under the right conditions, according to the NBS chemists.

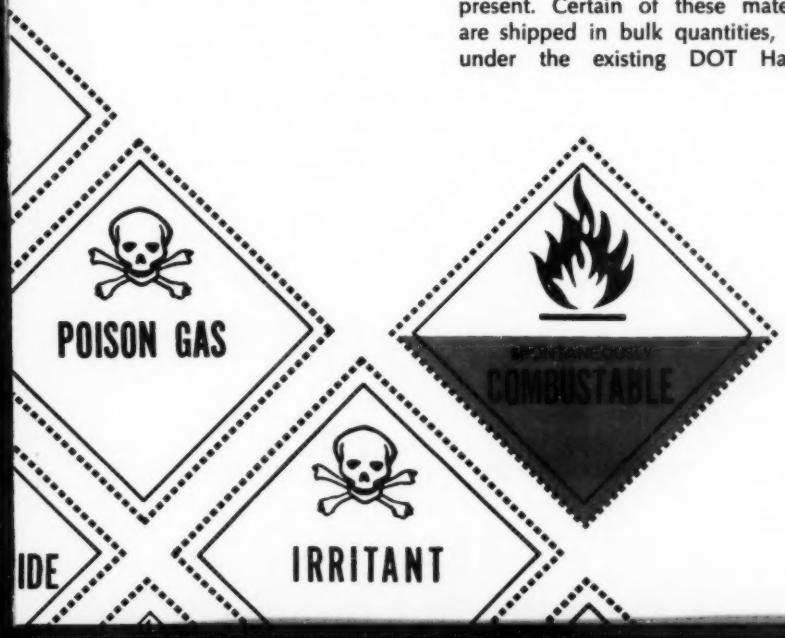
"Thermally unstable materials," said Domalski, "can undergo self-decomposition without any oxygen present. Certain of these materials are shipped in bulk quantities, and, under the existing DOT Hazard Classification System, some are classified as poisons, flammable liquids, oxidizers, corrosive liquids or flammable solids."

"This classification system," Domalski emphasized, "does not suggest their thermal instability."

One example of an imprecisely classified material is anyhydrous hydrazine, a component of rocket fuel. Its classification as a corrosive liquid does not indicate its hazard potential to self-decompose into nitrogen and hydrogen.

"Hydrazine could decompose or explode under the right conditions," said Domalski, "if it is heated abruptly or excessively."

Other examples include picric acid, classified as a flammable solid, and chloropicrin, classified as a poison. Both of these materials are thermally unstable and could be hazardous under the right conditions.



Method of the Study

Domalski and Tsang began their study by reviewing the existing methods of hazard evaluation—namely the examination of thermochemical predictive schemes and explosive sensitivity test data. The predictive schemes they evaluated are computer programs which read and analyze the formula for a chemical substance, predict the substance's reaction products and rank its hazard potential on the basis of certain calculated parameters.

After evaluating the two main predictive schemes and the available

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Safety of Playground Equipment

- **A 9-year old girl fractured her skull when running under a swing set.**
- **A 6-year old boy had his finger amputated when caught in the linkage of a swing set.**
- **A 2½-year old girl fractured her leg when dismounting from a moving swing.**
- **A young girl had her eye knocked out of its socket when struck by a swing.**

THESE are just a few selected samples of the more than 125,000 injuries caused each year by playground equipment. There may be many more injuries but the 125,000 represent those children—and a few adults—whose injuries require hospital emergency room treatment, as estimated by the National Electronic Injury Surveillance System (NEISS).

Every parent who has ever watched his child climb to the top of a jungle jim or sail in a wide arc on a swing set has done so with some fear and trembling. That anxiety appears justified based on studies performed by the National Bureau of Standards for the Consumer Product Safety Commission on home playground equipment.

NBS found that home playground equipment is often poorly designed and constructed. There are numerous pinch points, protrusions, sharp hooks and hard swing seats. "Design and construction defects, when combined with misuse or abuse of these products during unsupervised play, lead to traumatic mishaps," states Dr. Bal M. Mahajan of NBS' Measurement Engineering Division which conducted the studies.

NEISS data indicate that 57 percent of the 125,000 injuries occur on home playground equipment. A detailed NBS study of the summary analysis of this data "indicates that a large number of these injuries could have been prevented if more foresight had been used by the playground equipment manufacturers," the NBS researcher states in a summary of his work.

NEISS data indicated that the highest incidence of mishaps (at least 64 percent) involved swing sets, and the second highest incidence (approximately 16 percent) of mishaps involved slides. Consequently, NBS concentrated on studying swing sets as a first priority.

Various swing sets were tested using weights to represent the force exerted by children in their play. One test measured the peak impulsive

force to which a child may be subjected when impacted by a moving seat. Since the force resulting from such an impact is dependent upon the seat's construction features (mass, material, rigidity and so forth), different seats produced a different amount of force. For example, wooden seats, which are hard and have substantial mass, produced the greatest amount of force—4,900 newtons or 1,100 pounds. Lighter and more flexible plastic seats generated 1,400 newtons (314 pounds) of force; sheet metal seats, which are hard but generally lightweight, developed 2,336 newtons (524 pounds) of force. The least amount (890 newtons or 200 pounds) was generated by a plastic seat which had the underlying rib structure modified to make the front edge more flexible and the whole swing seat lighter.

Chances are high, the NBS engineer believes, that a child struck squarely by a wooden seat will receive a skull fracture. He rates the chances of a fracture as slight from being hit by a properly designed plastic seat.

Mahajan's group also tested the strength and stability of swing seats. "We estimated the various forces that home swing sets will be subjected to," he notes. To perform these tests, NBS purchased home playground equipment and installed it on the Bureau grounds in Gaithersburg, Md.

A swing set, which was anchored to the ground utilizing four steel ground anchors in accordance with the written instruction provided by the manufacturer, was tested for stability. It took 1,000 newtons (225 pounds) force, applied to the top bar in a direction parallel to the ground and perpendicular to the top bar, to pull out of the ground the two anchors which were supposed to resist the moment of this force. This force generated a little over half of the estimated tipping moment that this swing set is likely to experience when all swing units of the set are in phase.

turn page

PLAYGROUND *continued*

The test showed, the NBS researcher said, that certain sets could collapse or tip over under the forces produced by swinging children if every seat were occupied.

Another test involved placing weights on a dome-shaped climber made of steel-alloy tubing. It took only 890 newtons (200 pounds) of force to cause the vertex of the climber to collapse. Mahajan estimated the vertex of the climber would collapse completely if five 27-kilogram (60 pound) children hung from five strategic points on the climber.

Other weaknesses and hazards found by the NBS researchers on home playground equipment included pinch points—holes or slots where children's fingers or toes may become caught, bolts that are not cut flush with the nut and that serve to catch loose clothing and shoelaces, sharp ends on swing chains that can produce lacerations and a variety of sharp edges and points. They also noted that hexagonal nuts are preferable to square nuts as playground equipment components because the edges of hexagonal nuts are not as sharp as those on square nuts.

Mahajan's report notes that "approximately half of the swing-set-related mishaps are due to design and construction defects of the product." However, he also reports that the playground equipment industry has recently drafted its own proposed safety standards for home equipment, thus showing its concern about the safety question. □

HIGHLIGHTS

Mobile Home Projects

Due to the growing number of Americans who live in mobile homes, NBS is conducting five mobile home research projects to learn more about fire safety, energy use, performance standards and other problems involved with these homes. The studies, sponsored by several Federal agencies, a manufacturers' association and a standards organization, are aimed at reducing mobile home losses—particularly those caused by fire and wind.

SURF 2 Is Up

The amount of ultraviolet radiation available for NBS experiments has been increased by as much as 100,000 times with the completion of the new Synchrotron Ultraviolet Radiation Facility (SURF 2) at NBS. Present efforts center on perfecting the injection and acceleration procedures, tuning for highest achievable energy and maximizing the current accelerated. So far, 0.3 mA currents have been attained at 240 MeV with 2-hour lifetimes.

Experimental programs utilizing the new facility are expected to begin early in 1975. The projects will be concentrated in the areas of radiometry, surface physics, atomic cross-sections and studies of the optical properties of organic materials.

Optical Character Recognition

A standard (FIPS PUB 32) for the description, scope and identification for character sets of graphic shapes to be used in the application of optical character recognition systems was recently published by NBS. Two font styles, as well as three character sizes, are described.

The standard is available as SD Catalog No. C13.52:32 from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for $1.40.

Highest Frequency Measurements

Scientists at NBS Boulder have made the highest direct frequency measurement to date. The measurements were made of two xenon laser frequencies in the near infrared—the 3.5 μm line, 85.459997 THz, and the 2.03 μm line, 147.915850 THz.

This extension of the frequency synthesis chain from microwave wavelengths to 2 μm increases by 50 percent the spectral range open to accurate frequency measurements.

Roofing Conference

The fourth national conference on roofing technology, sponsored by NBS and the National Roofing Contractors Association, will be held April 22-23, 1975, on NBS' Gaithersburg, Md., campus.

At the conference, members of the building and roofing industries and government representatives will discuss roofing performance standards, effects of heating on the performance of asphalt, energy conservation and roofing performance and moisture detection and control in roof structures and roof insulation.

New Josephson Device

A novel microstripline-coupled Josephson device has been developed at NBS for use in improved 2e/h voltage standards based on the Josephson effect in superconductors. The new device combines precision dc metrology and modern microwave integrated circuit technology. It is ideal for use either in one of the many all-cryogenic voltage standards being developed around the world, or in any conventional 2e/h voltage standard as a more compact and efficient substitute for cumbersome waveguide-coupled devices.

Gas Cylinder Specifications

In order to keep up with changing technology and materials shortages, NBS is helping the Department of Transportation's Office of Hazardous Materials revise and consolidate its specifications for seamless, steel, high-pressure compressed-gas cylinders. Technical assistance from NBS involves advice and consultation about materials, heat treatment and mechanical qualification tests.

Laser Power Meter

Using the concept of an electrically calibrated pyroelectric detector, NBS has developed a completely self-contained system for the measurement of laser power. The instrument uses closed-loop electronics to continuously balance electrical and optical inputs. It converts optical measurements directly to S.I. electrical units and allows for dynamic tracking of continuously changing power levels.

Four of these units have been built and are presently undergoing parallel, long-term evaluations.

More on Appliance Efficiency

There will be a new appliance efficiency program at NBS as a result of President Ford's energy program announced in his State of the Union Message. The goal of the Voluntary Program for Appliance Efficiency—as it will be called—is to reduce energy use of new home appliances by 20 percent by 1980. □

New Time Rules

A small change in the regulations controlling standard time signals, such as those broadcast by National Bureau of Standards radio stations, WWV, WWVH and WWVB, went into effect on January 1, 1975.

Mainly of interest to those who must make astronomical determinations of their position on earth, the change extends the allowable difference between atomic time and sun time—that is, between the time scales known as "UTC" and "UT1"—from 0.7 second to 0.9 second.

UTC (Coordinated Universal Time) is the internationally coordinated time scale used around the world for most timekeeping purposes and is generated by reference to atomic standards. UT1 is a form of astronomical time referred basically to the rotation of the earth and is used primarily by navigators, geodesists and others needing to determine their position on the earth's surface by astronomical observations.

Owing to the irregular rotation rate of the earth, UT1 and UTC do not usually coincide. The difference between them prior to January 1, 1975, was not permitted to exceed $\pm$ 0.7 second, and this tolerance was maintained through the insertion (or subtraction) of leap seconds in UTC. The recent change in tolerance, to $\pm$ 0.9 second, permits greater flexibility in assigning the dates of the leap second. Now, it will be more likely that leap seconds will occur only on June 30 or December 31. Users will not be affected by this change, if they are not sensitive to the original $\pm$ 0.7 second tolerance.

Concurrent with the above change, another operating rule was adopted to allow leap seconds, when necessary, to occur on March 31 and September 30. First preference, however, will still be given to the June 30 and December 31 dates when practical.

The change in tolerance between UT1 and UTC obliges a small change in the way time broadcast stations code the information about the current difference (DUT1) into their broadcasts. DUT1 is given to the nearest 0.1 second and represents the quantity: (UT1—UTC) $\pm$ 0.1 second. The new code is basically the same as the old one, except that it now accommodates DUT1 values up to $\pm$ 0.8 second. (Extension to $\pm$ 0.9 second was considered unnecessary because of the $\pm$ 0.1 second uncertainty of DUT1.).

Thus, since January 1, 1975, the emphasized seconds pulses indicating magnitude of DUT1 have occurred on the first through eighth seconds after the minute marker (indicating positive values of DUT1) or on the ninth through sixteenth seconds (indicating negative values). The number of emphasized pulses gives the sign. For example, if emphasized pulses are heard on the 9th, 10th, 11th and 12th seconds, DUT1 = —0.4 second $\pm$ 0.1 second, and the UTC broadcast is 0.4 $\pm$ 0.1 second early with respect to UT1. Pulses from WWV and WWVH are emphasized by doubling.

The above changes were authorized by "Recommendation 460 (1974 revision)," approved by International Study Group 7 and enacted by the International Radio Consultative Committee (CCIR) in July 1974 at Geneva. □

1975 Arrived Late

THE new year was a little late again this year. The delay was caused when a "leap second" was added to the world's time scale between the very end of December 31, 1974, and the very beginning of January 1, 1975.

At that time, scientists at the National Bureau of Standards laboratories in Boulder, Colo., stopped a precision clock for exactly one second while scientists in precision time laboratories around the world did the same. Thus a "leap second" was added to the time scale.

Leap seconds were invented in 1972 when people increased their reliance on the atomic clock instead of the earth as the primary timekeeping device. The reason for the change is the unpredictable and slowing rotation of the earth. This requires that clocks based on the earth's rotation incorporate the same variations—making hours, minutes and seconds vary in length according to the erratic rotation of earth.

Atomic clocks tick off hours, minutes and seconds of essentially the same length—a condition that is not only an academic advance but also an absolute necessity for technical developments such as space travel and sophisticated communication and navigation systems.

On the other hand, atomic clocks come not as an unmixed blessing. Running as they do at a virtually constant rate, they get ahead of the earth, a condition that, if allowed to go uncompensated, would result in 12 o'clock noon (and every hour of the day) getting earlier and earlier. Twelve o'clock noon would progressively approach dawn instead of remaining near the instant when the sun is at the meridian (directly over head).

The result would be unimaginable difficulties with any number of earthly activities, but particularly it would cause problems for aircraft and seacraft navigators who use time of day and location of celestial bodies to locate their positions.

In order to avoid such problems, the world's timekeepers agreed never to let the atomic clocks and the earth get more than 9/10 of a second out of synchronization; that's close enough so not even the navigators object.

To maintain this synchronization, the clocks are stopped for one second when necessary to let the earth catch up or even get a little ahead. These are the "leap seconds" added to the time scale, so named for their analogy to the extra day added on leap year to keep the calendar synchronized with the earth's orbiting cycle around the sun.

Leap seconds are added at the direction of the world time-keeping organization, the International Time Bureau in Paris. By international agreement leap seconds are added to the international time scale (Coordinated Universal Time or UTC) at the end of the day on the zero meridian. Accordingly, leap seconds are added in other parts of the world at various times of day depending on the time zone. The first was added at the end of the day of June 30, 1972; the second at the end of December 31, 1972; and the third at the end of December 31, 1973. □

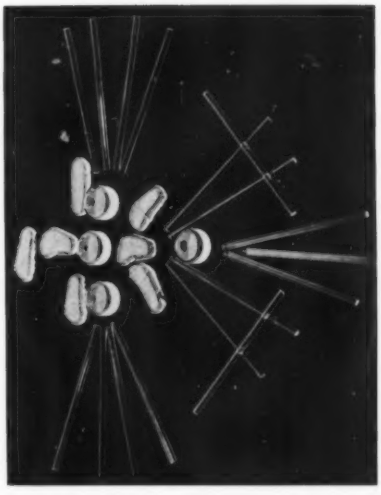
Fifty Glass Standard Reference Materials Available

MORE than 50 Standard Reference Materials (SRM's) of interest to the glass industry are available now from the National Bureau of Standards.

In addition to three glass viscosity standards covering a wide viscosity range, NBS also has SRM's for glass viscosity fixpoints, relative stress optical coefficient, thermal expansion standards, chemical composition standards, specular spectral reflectance standards, sizing standards and others.

Standard Reference Materials are materials whose chemical compositions or particular chemical or physical properties have been accurately determined and certified. NBS Standard Reference Materials are used throughout industry and the scientific community to calibrate and evaluate measurement instruments and test methods. Because of their well defined composition, preparation conditions and properties, SRM's have also found their way into scientific research.

A new pamphlet describing NBS Standard Reference Materials for Glass Industry and a complete list of available NBS-SRM's with prices may be obtained from the Office of Standard Reference Materials, Room B311, Chemistry Building, NBS, Washington, D. C. 20234. □



Facts on High Rise Fires

ALTHOUGH it is common to speak of a high rise fire problem, there has been, in fact, not much of a problem in the United States to date. In the decade 1962 to 1972 there were 12 fatalities in high rise building fires in the United States. In that same period there were 60,000 fatalities in residential fires.

Following are some facts on high rise building fires that were compiled by the National Bureau of Standards from a report[1] by Gregory A. Harrison of NBS' Center for Fire Research. This Center serves as a research arm of the Commerce Department's comprehensive program to reduce fire losses. As such it works closely with the recently established National Fire Prevention and Control Administration.

High Rise Buildings Can Have Unique Fire Problems

There are various definitions of what constitutes a high rise building. For purposes of this article, it will be considered any building generally beyond the reach of aerial ladders. High rise buildings present several potential fire problems not normally encountered in other buildings. Some examples:

- The time required for occupant evacuation is far greater than for conventional buildings. This is simply an unavoidable result of the sheer size of the structure.
- Smoke hazards are especially prominent in high rises. This is because utility spaces, elevator shafts and other vertical penetrations offer many potential avenues for smoke to permeate the structure.
- Fire departments have difficulty in fighting high rise fires. Ladders are generally much shorter than the building, and firefighters usually must use the building's own facilities to reach the fire.
- Elevators are the usual means of transport in a high rise, but they are generally *off limits* once a fire breaks out. This is because of the smoke hazard offered by elevator shafts, and because elevator call systems may sometimes mistakenly direct the cars to the fire floor, thereby exposing the occupants to the fire's full intensity.
- New construction and decor materials, such as certain plastics, may have greater potential for flame spread and smoke generation than traditional materials.

High Rise Buildings Have Favorable Fire Record

Fire losses in high rises are frequently lower than losses in other structures. Statistics defining the magnitude of New York City's high rise fire problem are typical of high rise fire statistics in other parts of the United States. There are 2,000 office buildings in New York City of which 800 are high rise buildings. In the past 5 years, of the 1,400 fire deaths in New York 19 occurred in office buildings, six of which were in high rise buildings. Fire fatalities occurring in high rise buildings in the United States are so low that they have not affected insurance premiums for liability. Statistically, the overall risk of dying in a high rise fire is less than that of being struck by lightning.

This safety record can be attributed to American building code technology and the code enforcement system, which has generally been very successful in preventing disastrous high rise fires.

Nevertheless, there is no room for complacency. New materials and new building practices are being used daily. Maintaining the good safety record will depend on how carefully we determine the fire hazards these new materials and practices present.

High Rise Fire Safety Must be Designed into the Building

Many fire safety measures are available to building designers. It is their responsibility to incorporate current technology into their buildings to maintain the high rise fire safety record. One such system is automatic extinguishment, specifically sprinkler systems which have experienced an extraordinary efficiency record in the past. Similarly, technology exists to control the movement of smoke and gas, often the most dangerous aspect of fire. In particular, design concepts to produce smoke-free zones (such as pressurized stairwells and smoke-proof towers) can control smoke movement in a building, thereby protecting occupants who may remain inside the burning structure.

You Are Your Best Fire Safety Tool

Here are some things you, as an occupant of a high rise building, should do:

- Immediately, learn the fire safety procedures of your building. If no fire safety program exists, *insist* that the management provide you with instructions for proper emergency measures. You should be aware of the location of escape routes, the existence of a voice command system, if any, and the existence of the building's fire protection and smoke con-

[1] G. A. Harrison," The High-Rise Fire Problem," CRC Critical Reviews in Environmental Control, *4* (4) 483 (1974).

trol measures which might influence your evacuation decisions.

- If the management is unable or unwilling to provide you with such information, contact your local fire department.
- In case of fire, follow the instructions given by management or the fire department. Unless the fire department tells you otherwise, *stay away from the elevators*. Stairways are designed to be the best means of safe escape.
- If you encounter fire or smoke, stay close to the floor and cover your mouth and nose with a towel or handkerchief to minimize inhalation of toxic combustion products. □

Workshop on Surface Finish of Silicon Devices

THE analysis of silicon and associated insulator films and device structures by modern analytical beam techniques will be the topic of a workshop on April 23 and 24, 1975, at the National Bureau of Standards, Gaithersburg, Md.

The workshop, which is being sponsored by the National Bureau of Standards and the Defense Advanced Research Projects Agency (ARPA), is intended to explore the present qualitative and quantitative capabilities and future prospects of techniques using impinging electron, ion, neutral and photon beams in measurements important to the semiconductor industry. Of particular interest will be the application of these techniques for the determination of impurity profiles, surface contamination and interface characteristics.

The workshop will feature prepared talks and open discussions on a variety of modern techniques such as: Auger electron spectroscopy (AES), secondary ion mass spectroscopy (SIMS), ion scattering spectroscopy (ISS), nuclear resonance and Rutherford backscattering (RBS), surface composition by analysis of neutral and ion impact radiation (SCANIIR), X-ray photoelectron spectroscopy (XPS or ESCA), ultraviolet photoemission spectroscopy (UPS) and photovoltaic and photodepopulation measurements.

Discussions will be fostered between analysts, users of their results and instrument manufacturers.

The workshop is the fourth in a series of ARPA/NBS workshops concerned with measurement problems in integrated circuit processing and assembly. A workshop report will be prepared after the meeting and will be available as an NBS special publication.

The NBS work on the analysis of silicon and of silicon surfaces and interfaces is part of an ARPA-sponsored activity titled "Advancement of Reliability, Processing and Automation for Integrated Circuits with the National Bureau of Standards." This activity is a major element of an NBS program which seeks to develop and to disseminate to the electronics community carefully evaluated and well-documented test procedures and associated technology to solve measurement and standardization problems in connection with the manufacture, procurement and application of semiconductor devices.

Additional information about the workshop may be obtained by contacting Kathryn Leedy (301/921-3625), Building 225, Room B346, National Bureau of Standards, Washington, D.C. 20234. □

experimental test data, they correlated hazard ratings from the predictive schemes with hazard ratings indicated by the experimental tests for about 60 materials. On the basis of their correlations, they critiqued the predictive schemes and recommended directions for future research.

Predictive Schemes

The two predictive schemes reviewed by Tsang and Domalski were CHETAH (*Ch*emical *T*hermodynamics *A*nd Energy *H*azard Evaluation), developed by the American Society for Testing and Materials Committee E-27, and CRUISE, named for its developer D. R. Cruise and used at the Dow Chemical Co. in Midland, Michigan.

The CHETAH and CRUISE programs analyze chemical formulas to provide information about certain parameters, or characteristics, of the substances' reactions. Tsang and Domalski identified three parameters as important to the study of thermally unstable materials which were derived from the programs.

The heat of decomposition, or the heat of reaction, was found to be a parameter calculated in both programs and used for rating a substance's hazard potential. A second important parameter is oxygen balance—the percentage of oxygen needed to convert a reactant completely to its normal combustion products. "Some materials, like nitroglycerine, need no outside oxygen to self-react and cause an explosion," said Domalski.

The third relevant parameter they identified was activation energy—the amount of energy needed to cause a substance to react.

Experimental Test Methods

After examining predictive schemes, the scientists looked at various experimental test methods for explosives which could be used to increase their understanding of thermally unstable materials.

The simplest and most widely used test for assessing material sensitivity is the impact test, in which a weight is dropped from a given height on a small sample of the substance. The test indicates the minimum height, or minimum impact, which will result in an explosion.

In the explosion temperature test, a sample of the test substance is loaded into a container with blasting caps and immersed in a Wood's metal bath for 5 seconds. The temperature at which the sample explodes, ignites or decomposes is then recorded and used as an estimate of the sensitivity of the material.

Liquid substances can be tested by the thermal surge test, in which the sample is loaded into hypodermic needle tubing, and a capacitor is discharged across the tubing. The capacitor's spark sets off an explosion, and the substance's reaction temperature is indicated by the tubing's electrical resistance.

Evaluating Existing Hazard-Rating Methods

After correlating the predictive schemes' ratings with the results indicated by experimental tests, the scientists concluded that these "predictive schemes did not rank certain materials correctly. None of the correlations gave a one-to-one relationship."

"We wanted to see if the predictive schemes provided a reasonable ranking of materials from high sensitivity to inert, and we found that on the average they did," said Domalski. "However, certain dangerous materials were ranked as medium or low

Photo courtesy Department of Transportation

hazard by the predictive schemes when they should actually have been rated as high."

Of the three relevant parameters, activation energy was found to have the best correlation with test data, while oxygen balance ranked second, and heat of decomposition had the poorest correlation.

In an effort to improve the predictive schemes, the scientists tried changing the rules used in the schemes for selecting reaction products. "We found that if you change some of the rules in the predictive schemes to fit observed experimental test data, you can get better agreement," Domalski said.

Reaction Mechanisms

By changing the rules in the predictive schemes, the scientists were led to other improvements. The way in which certain compounds decomposed to give similar reaction products suggested they be grouped according reaction mechanism. "Some groups of compounds responded to some of our rule modifications, while some groups responded to others," said Domalski.

"The original schemes were not oriented enough toward how Mother Nature carries out a reaction," he continued. "Butane, acetone and TNT will follow different reaction paths in their decomposition."

Three reaction mechanisms into which self-decomposition reactions could be divided, according to Domalski, are bond-breaking, polymerization and molecular elimination.

For example, a hazardous bond-breaking reaction can occur when the nitrogen-carbon bond breaks in nitromethane, ultimately forming methane, nitrogen oxides, carbon monoxide and carbon dioxide.

Polymerization can occur in a substance like ethylene, which consists of two double-bonded CH_2 groups. "If one of the bonds breaks, CH_2 groups will tag onto each other indefinitely," said Domalski. "This reaction will give off a lot of heat. If it's in a tank car in a confined space, conditions could become such to cause the tank car to rupture, or it might mix with air and cause a fire."

Elimination reactions appear to be a third group of processes which facilitate the classification of reaction mechanisms. A molecular elimination can occur, for example, in nitroethane when the nitro group combines with one of the hydrogen atoms in the molecule to form nitrous acid and splits off a molecule of ethylene.

Conclusions

"A more useful predictive scheme should be based on reaction mechanisms," concluded Domalski, "although separate programs for each reaction mechanism would be needed. No single reaction mechanism or process could accurately handle all substances as is presently attempted."

"For the present, we suggest looking at the reactive groups contained in the various substances to identify them as potentially self-reactive," he continued. "If a substance contains a nitro, azide, or peroxide group, it should be suspected as hazardous. This method is safer than using the existing programs."

Finally, the NBS chemist concluded, experimental test data are the best hazard indicators. More test data are needed, he asserted, to create a more reliable system for assessing the hazard potential of self-reactive chemicals. It is possible that these studies may lead to new test procedures which can assess explosive sensitivity more accurately. □

science have not yet devised a valid system of judging the value of a person's work. But let's assume the work is reported as a valid contribution to the fund of scientific knowledge. If so, the author should include enough relevant information so that others can truly evaluate the reliability of his data. To do so, of course, means that he must first satisfy himself that the data are reliable.

There is also a responsibility on the part of professional journals to provide their readers with papers whose data can be evaluated. It would be unthinkable for a journal to publish a paper stating merely that the atomic weight of element X had been determined and the value was such and such. It should be equally unthinkable for journals to accept and publish any papers in which the authors do not discuss the sources and extent of possible systematic errors.

Yet a consensus of data evaluation experts say that fully 50 percent, or even more, of the data reported in the literature are unusable, not because of error but because too little information has been provided with which to make an independent evaluation of their reliability. Here we have often perfectly good science producing if not bad data certainly unusable data. Thus journal editors, the reviewers of submitted papers and the professional societies that publish so many of our journals should all take a tougher stand on the papers that are submitted. Criteria for acceptability must be established, widely publicized and utilized. Such a stand will not be easy, but it would be a tremendous aid in the task of reducing data pollution.

The first steps in this direction have already been taken. CODATA (The Committee on Data for Science and Technology) has issued a general "Guide for the Presentation in the Primary Literature of Numerical Data Derived from Experiments." Specific guidelines or criteria relevant to particular classes of data have also been prepared, including thermodynamic data, data of chemical kinetics and infrared, NMR and Raman spectral data. Criteria for mass spectral data are being developed.

The Joint Committee on Atomic and Molecular Physical Data (JCAMP) is working closely with the NBS Office of Standard Reference Data in these latter areas. JCAMP has already held meetings with some journal editors to explore the possibility of applying these criteria in the publication process.

NSRDS Established

As long ago as 1963 the Federal Council for Science and Technology recognized the data problem and asked the National Bureau of Standards to manage a National Standard Reference Data System (NSRDS). The Council was motivated by at least two considerations.

First, it recognized that technological progress is based upon good science and good data, and thus it was in the national interest to provide both. Secondly, the Federal government is by far the single largest research sponsor and it, of course, wants to make sure that the data produced in its behalf are of high quality and that they can be used efficiently by all who need them. This assignment to NBS was reinforced by an Act of Congress in 1968, which states the intent of Congress to provide critically evaluated data for use by science, industry, universities and the public.

It was apparent that NBS couldn't do all the work, so we have become the coordinating point for a network of data centers. Most of these centers do not create new laboratory data, although some of them do. Their main task is to review the literature and to publish critically evaluated data compilations. They also collect and publish bibliographies in their special areas. For example, the Chemical Thermodynamics Data Center has data from 41,000 references on 25,000 materials, and has published evaluated data on over 10,000 compounds.

In these efforts we are aided by other U.S. data programs (for example, the Energy Research and Development Administration, the Environmental Protection Agency, the Department of Defense, the Department of Transportation and the Copper Development Association) and by data programs in other countries.

Our hope is that the availability of evaluated data will greatly reduce the inadvertent misuse of data that are in error and help counteract those rare cases of deliberate misuse.

Although there are a variety of participants in the effort to provide reference data—NBS, other government agencies, university and industrial labs—I see the effort to provide a central focus as a legitimate role for government. The problem of data analysis is so vast that it takes a continuing, concerted effort at the national level to make real progress. Our efforts can be magnified, however, by the production and use of valid data by researchers and the fostering of such practices by professional societies. □

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